Smiths Aerospace

HUMS Ground-Based Station Automated Testing

FAA HUMS R&D Review Meeting

8 June 2006

Presentation by: Gary Scholl

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Presentation Topics

1. Smiths HUMS Experience

2. FAA HUMS research program overview

- Objectives
- Planned work tasks

3. Work to date

- Benefits of Autotest
- Tools
- Techniques
- Industry Best Practices

4. Summary

5. Questions

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Smiths Aerospace HUMS experience

Smiths HUMS implementation

HUM systems

- First generation "North Sea HUMS" installed from 1991
- Derivative systems: AHUMS, EuroHUMS
- GenHUMS
- Apache HUMS
- GenHUMS derivative systems

HUMS implementations

- > 450 HUMS equipped aircraft rising to
- > 20 operators worldwide
- Customer base split 50:50 military civil
- > 2M hours

Worldwide HUMS Customer Locations (Dec 2005)

Smiths HUMS implementation

North Sea HUMS
AHUMS

EuroHUMS

WAH 64-
Apache HUMS

UK MoD GenHUMS

Oman Lynx HUMS

AW 139 HUMS

Bell 609 HUMS

SH 60K HUMS

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The Smiths HUMS Support Centre

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Specialist customer service focussed engineering team

- 15 dedicated personnel
- 'One-stop' specialist facility for all customers and all HUMS support
- Back-up from full range of Smiths technical specialists in US & UK

Facilities and infrastructure to provide worldwide support based on the extensive installed customer base

- PC based technical / operator help desk
- Dedicated secure website
- Data analysis/management facility

Key support partnerships developed with:

Long Term Support

- Technical assistance (Help Desk)
- Data analysis support
- Training
- Software maintenance
- Logistics
- HUMS management reports
- Product through-life management
- Product steering / Benefit optimization – Maturity Working Groups

CAA Approved services and procedures ✓

eurocopter (an EADS Company), Bell Helicopter (A Textron Company), AGUSTA

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HUMS Related Research and Development

ProDAPS (Probabilistic Diagnostic and Prognostic System) DUS&T program

- AI-based data mining, data fusion, anomaly detection, reasoning and decision aiding/action planning technology
- Open architecture tools and software components for technology insertion into multiple platforms

FUMS (Fleet Usage Management System)

- Advanced fatigue and usage management technology
- Diagnostics, prognostics and life management
- Powerful data analysis and management system

Advanced sensing technology

- Electrostatic engine gas path debris monitoring
- Electrostatic oil debris monitoring

Information exploitation systems

- Web-based Advanced HUMS Anomaly Detection System
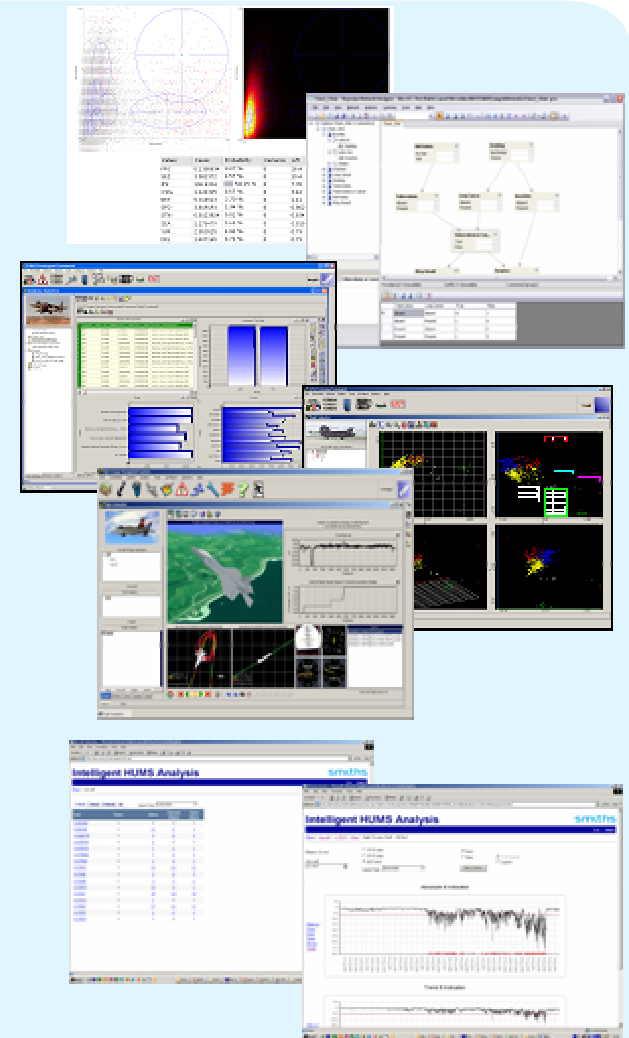
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FAA HUMS research program overview

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Objectives

- **Research and define current state-of-the-art tools, techniques, and best practices that can be applied to an HGS Automated Test Environment.**

- **Demonstrate that implementation of automated testing for an HGS fulfills the criteria for certification and subsequent credit validation requirements defined in AC-29-2C, Section MG-15.**

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Produce a Detailed Work Plan (completed October 05)

Deliverables

- Detailed Work Plan - Draft

- Oral Presentation of Detailed Work Plan

  - Work plan was presented at the October 18th, 2005 Kick-off meeting held at Smiths Grand Rapids facility.

- Detailed Work Plan – Final

  - Final Detailed work plan, with comments from Kick-off Meeting, was submitted November 4th, 2005

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Quarterly Reports

- Submit Quarterly Report on or before the 10th of the month following the end of the quarter
- First two reports have been submitted.

Annual Technical Report

- Final (15 October 2005)

Final Technical Report

- Draft (13 July 2007)
- Final (28 September 2007)

Task 3: Assess Current and State-of-the-Art Tools, Techniques and Best Practices

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Research Tools, Techniques, Best Practices related to automated testing

- Perform tool evaluations
- Evaluate techniques and best practices
- Define automated test environment

Deliverables

- Technical Report – Assessed Tools, Techniques, and Best-Practices
  - Draft (15 September 2006)
  - Final (13 October 2006)
- Technical Report – Recommendation of Best Practices
  - Draft (15 September 2006)
  - Final (13 October 2006)

Task 4: Validate Selected Tool for HUMS Automated Testing and Systems Functionality

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Research the effect of an ATE on the Certification Process

- Perform certification process evaluation

- Assess impact of COTS on certification process

- Extension of BA609 HGS Automated Test Environment

- Define process for writing/verifying automated tests

Deliverables

- Report – Process for writing and verifying automated tests and functionality partition

  - Draft (13 July 2007)

  - Final (13 August 2007)

- Report – Automated test and functionality partition validation and results

  - Draft (13 July 2007)

  - Final (13 August 2007)

Task 5: Implementation and Technology Transfer Plan

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Research the effect of an ATE on the Certification Process
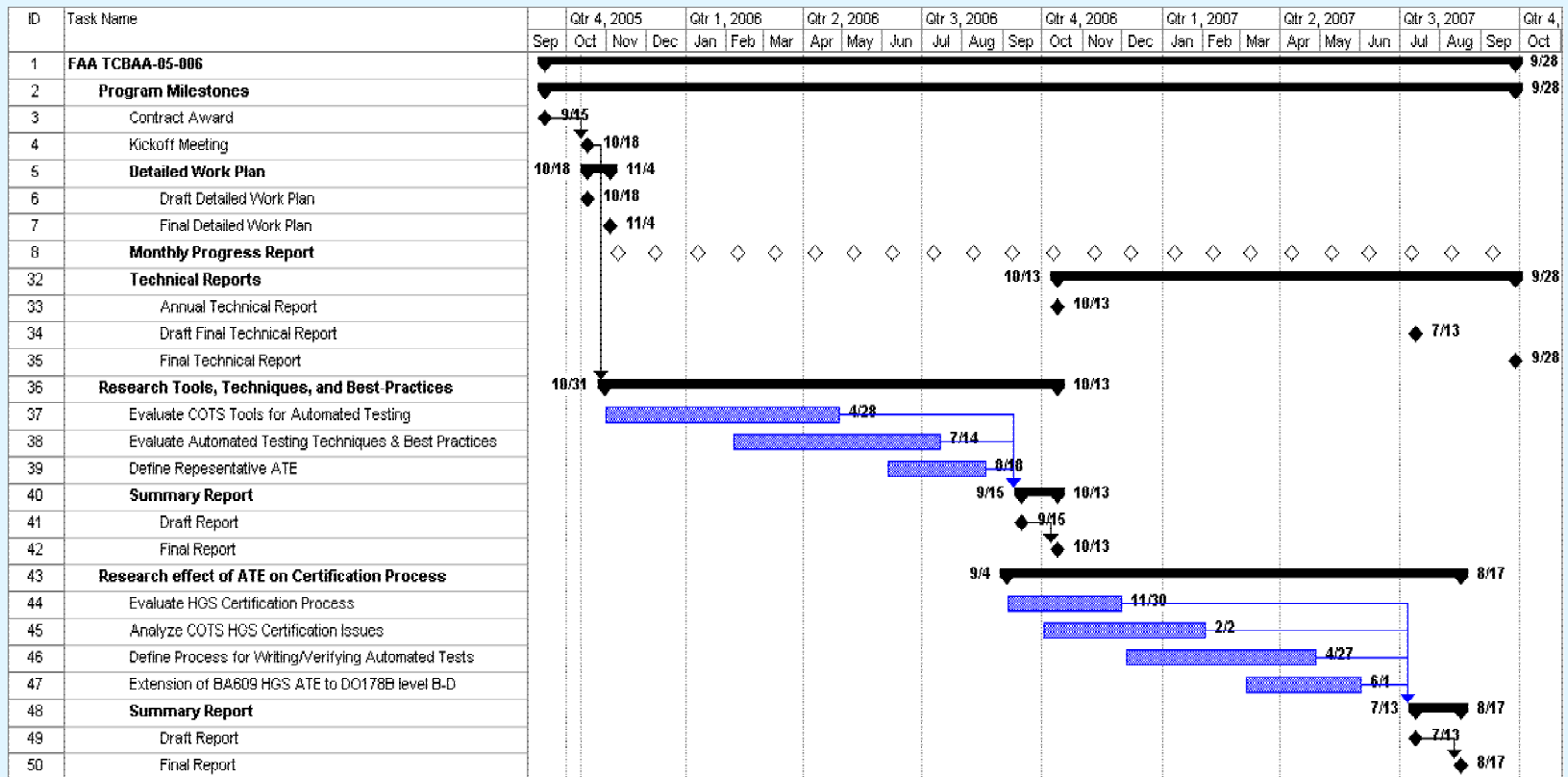
- Develop Certification Compliance Report

- Develop Implementation and Technology Transfer Plan

Deliverables

- Certification Compliance Report

  - Draft (13 July 2007)

  - Final (13 August 2007)

- Technology Transfer Plan

  - Draft (13 July 2007)

  - Final (13 August 2007)

Project Schedule

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Work to date on Task 3: Research Tools, Techniques and Best Practices

Automated Build and Test Benefits

The benefits of establishing an Automated Build and Test include:

- Ability to run the test suite repeatedly (regression testing) throughout development. Thereby, ensuring increased system robustness and reducing end full-up system test time.

- No manual testing effort. The marginal testing cost of a release with Automated Testing is zero.

- Provides confidence and easy introduction of new technologies.

- Frequent software releases to the customer are achievable.

- Provides an accurate method for tracking software development progress

Automated Build and Test Benefits

The benefits of establishing an Automated Build and Test include:

- Increase confidence in the quality of the integrated application.

- The latest software application build is consistently available to support System level testing and customer discussions.

- Enhances the design for future maintainability and extendibility.

- Keep working up until the release date – (do not need to reserve time for integration, testing and release)

Tools

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Identified and Categorized Tools to assist in Automated Build & Test.

- **Unit Test Frameworks (20 tools)**

- Developmental Configuration Management / Version Control (8)

- Build Automation Utilities (6)

- Build Scheduling & Continuous Integration (12)

- Documentation (7)

- Requirements Management / Project Management (5)

- Code Coverage Analysis (2)

- Knowledge Management (3)

- Problem Tracking (3)

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Tools

Within the Test Frameworks **category we identified a number of sub-categories of tools.**

- Native Unit Test Frameworks

- Mock Tools

- Static Analysis

- Dynamic Analysis

- GUI Test Tools

We will evaluate the importance and uses of tools in each of the categories based on variables including:

- Who will be testing the system?

- Which DO178B level required?

- Type of environment (Embedded, PC, etc)

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Studying successful Automated Test & Build Teams

- Burke E. Porter Machinery (Dyno Host Project)

- Smiths Aerospace (BA609 Project)

- DaimlerChrysler Core Tools & Processes Group

- Atomic Object

Industry Best Practices

Test Driven Development

- Short Iterations
- Automated Unit & System Tests

Documentation

Knowledge Management

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Program Status

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Schedule

- Currently behind schedule by roughly a month, due to staff working on the program that will be used for validation
- Subcontractor has been employed to aid in research and will help recover schedule
- Still planning to maintain schedule for deliverables

Budget and Expenditure Status

- Spending through second quarter is 5% of Yearly Allocation
- Spending Profile was expected to ramp up in second half of year
- Spending does not take into account work done in past month by both Smiths and subcontractor
- There is low risk of exceeding budget for this fiscal year

Risks

- No technical risks have been identified
- Schedule risk has been mitigated with subcontract

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Thank you for your attention

Questions?

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Additional Information on the Research To Date

Automated Test System

The automated test system is designed to work with the release version of the software, including any Non-Developmental Items (NDI) or COTS software. Typically none of the test functionality would be embedded within the released system.

The two main tasks that the Automated Test Application must perform are to stimulate functionality within the application and then to compare the actual outputs against verified expected results. When automatically testing software, one of the main challenges is to stimulate the application without going through the user interface. This often involves producing alternative interfaces that are only used during testing.

The Automated Test Application will usually be based on a COTS testing framework that takes care of organizing the testing and reports back the results in a consistent format.

Simple Automated Test

System being tested

NDI Software

COTS Software

Application Software

Automated Test System

Automated Test Application

Expected Results

Requirements Testing
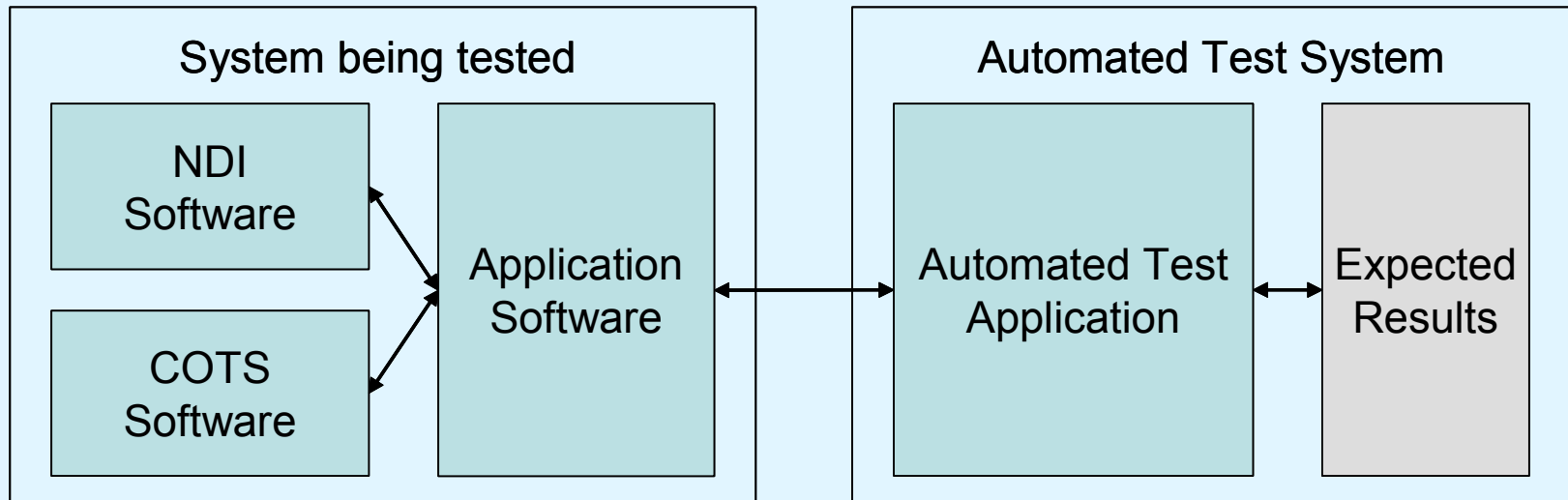
Tests written specifically to test a documented requirement.

Tests report DOORS requirement IDs that have been covered.

Many different strategies.

- Test at a high or low level.
- Drive the GUI.
- Mock out the GUI.

Unit Testing

Tests the low-level software in isolation.

Tests all functions of the software interface.

Easier to debug a Unit test than a Requirements test.

Simple Automated Build Infrastructure

1. Developer commits changes to DCM.

DCM Server

2. Build Server polls DCM server for changes.

3. When change is detected Build Server gets changes and initiates a build.

4. Results of build are reported to developers

Build Server

BA609 HUMS Automated Build Infrastructure

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Software Team

Grand Rapids

Germantown

Southampton

1. Developer commits changes to DCM.

Serena Dim. Server

2. Build Server polls Dimensions for changes.

3. When changes are detected Build Server initiates build process.

7. Person who checked in changes is emailed with the result of their check-in.

Build Server

4. Build Server baselines code in Dimensions.

5. Build Server gets baseline and starts a clean build.

6. If build is successful, automated test suite is run to test software.

Systems / Applications Team

Grand Rapids   Southampton

Systems / Applications team always have access to an up-to-date tested build

Web Server

8. Web page is published to show latest build results and metrics. If build was successful, installation software is made available for download.